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(54) VELOCITY ZONING HEAT EXCHANGER AIR BAFFLE

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(51) **Int. Cl.**

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F24H 9/00	(2006.01)
F24H 3/10	(2006.01)
F28F 3/12	(2006.01)
F28D 1/03	(2006.01)

(52) **U.S. Cl.**

CPC ***F24H 9/0063*** (2013.01); ***F24H 3/105*** (2013.01); ***F24H 9/0068*** (2013.01); ***F28D 1/035*** (2013.01); ***F28D 1/0316*** (2013.01); ***F28F 3/12*** (2013.01); *Y10T 29/49826* (2015.01)

(58) **Field of Classification Search**

CPC F24H 3/105; F24H 9/0063; F24H 8/00; F24H 3/087; F24H 9/0073

USPC ...... 126/99 D, 99 R, 110 R, 116 R, 112, 170, 126/159

See application file for complete search history.

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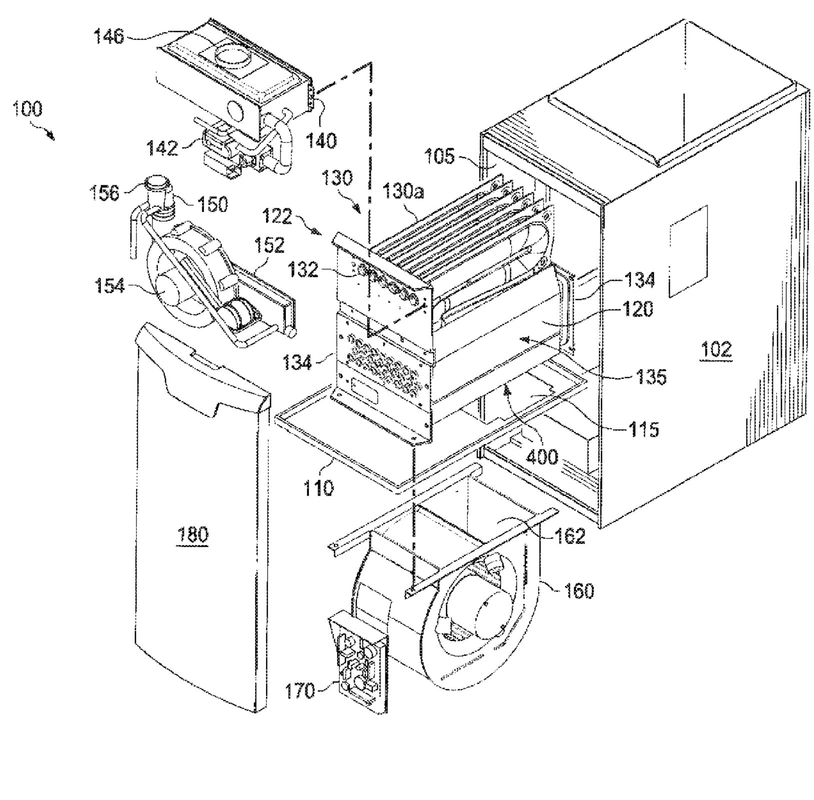
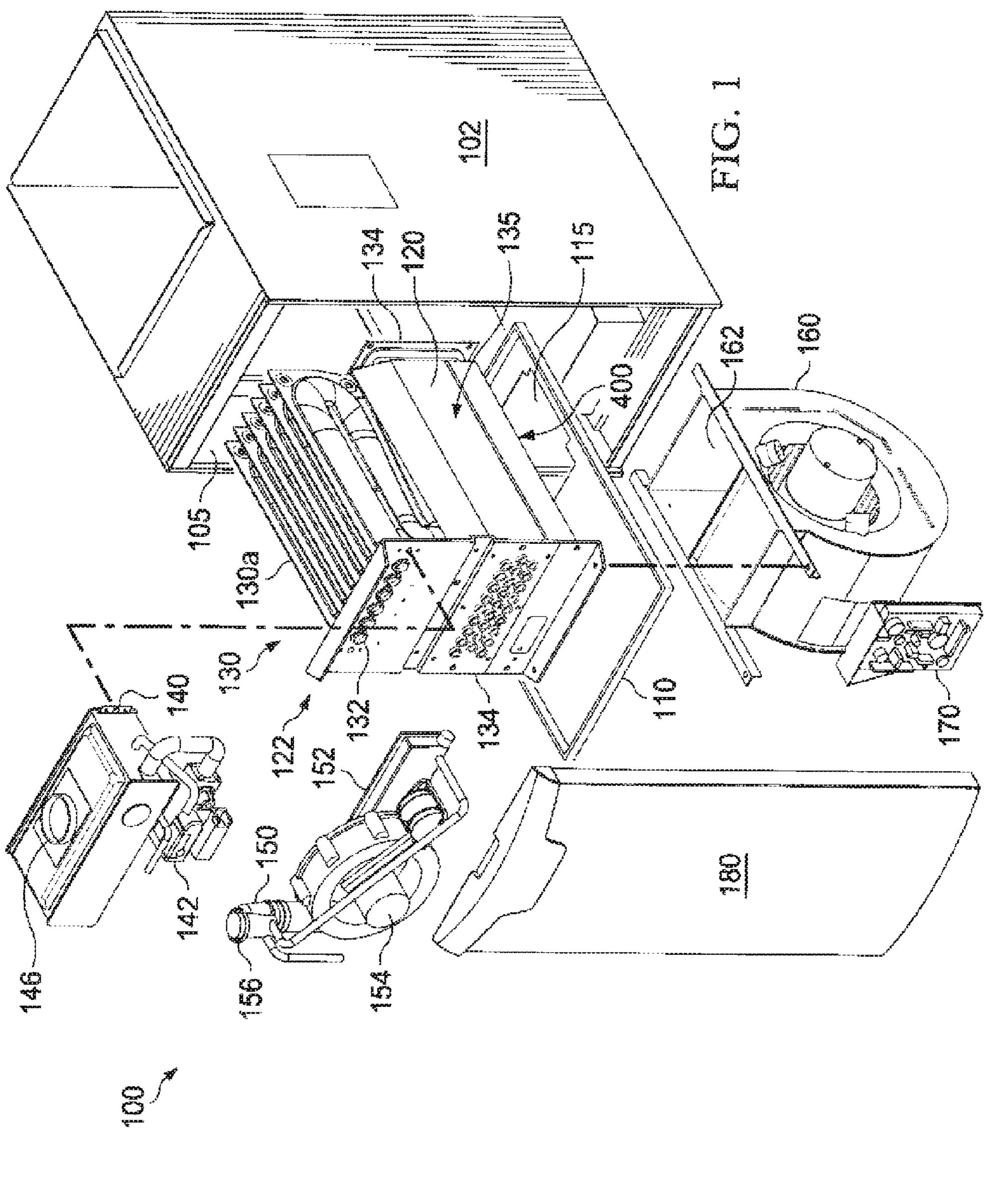
(57) **ABSTRACT**

One aspect of this disclosure provides a zoning baffle for a gas furnace. This embodiment comprises a housing, a primary heating zone located in the housing and comprising one or more heating chambers. A blower having an exhaust opening is located adjacent the primary heating zone and is positioned to force air through the primary heating zone. A zoning baffle is located between the blower and the primary heating zone. The zoning baffle comprises spaced apart baffles oriented substantially parallel with the one or more heating chambers. A method of manufacturing a gas furnace is also provided.

17 Claims, 4 Drawing Sheets

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135
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400
162
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130a
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FIG. 1

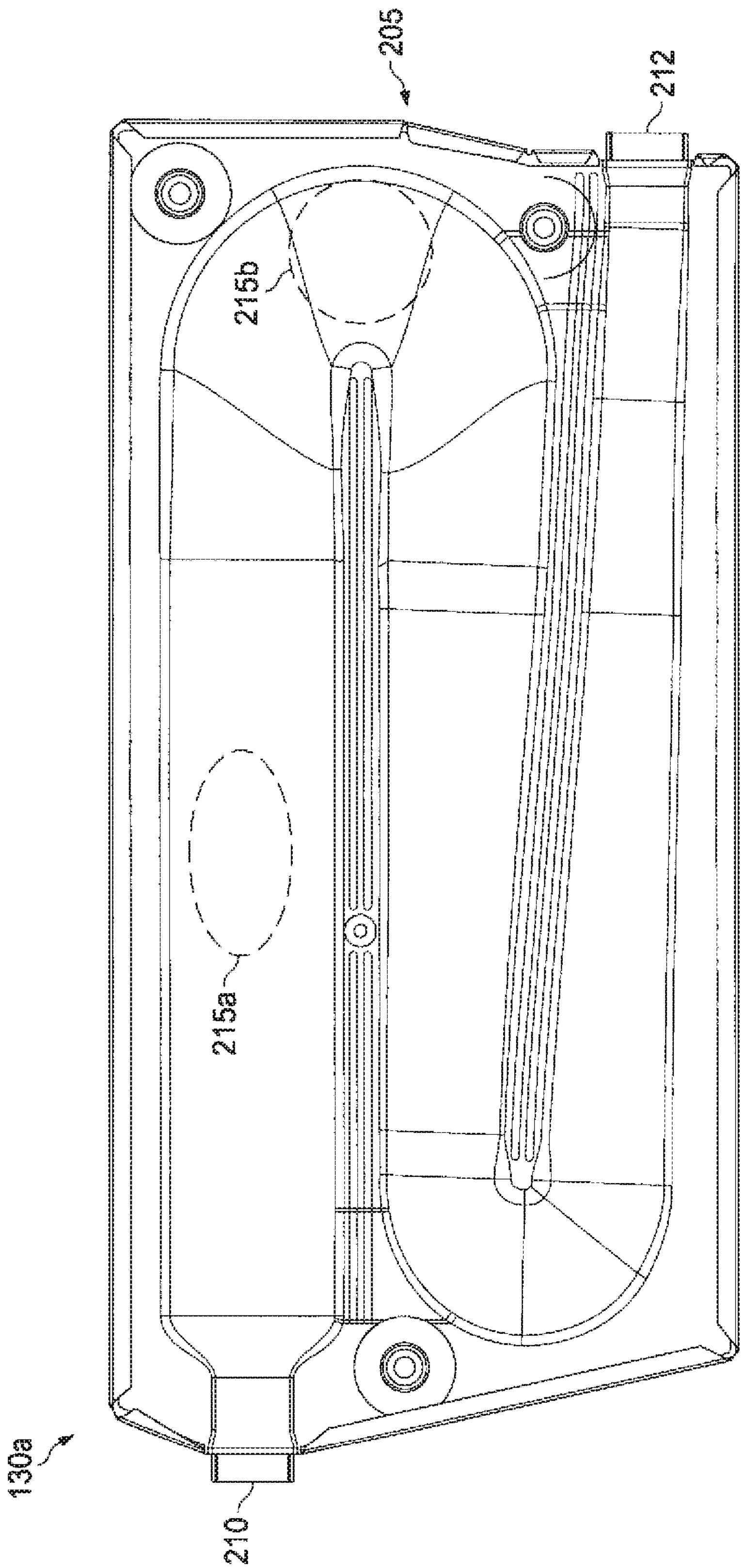


FIG. 2

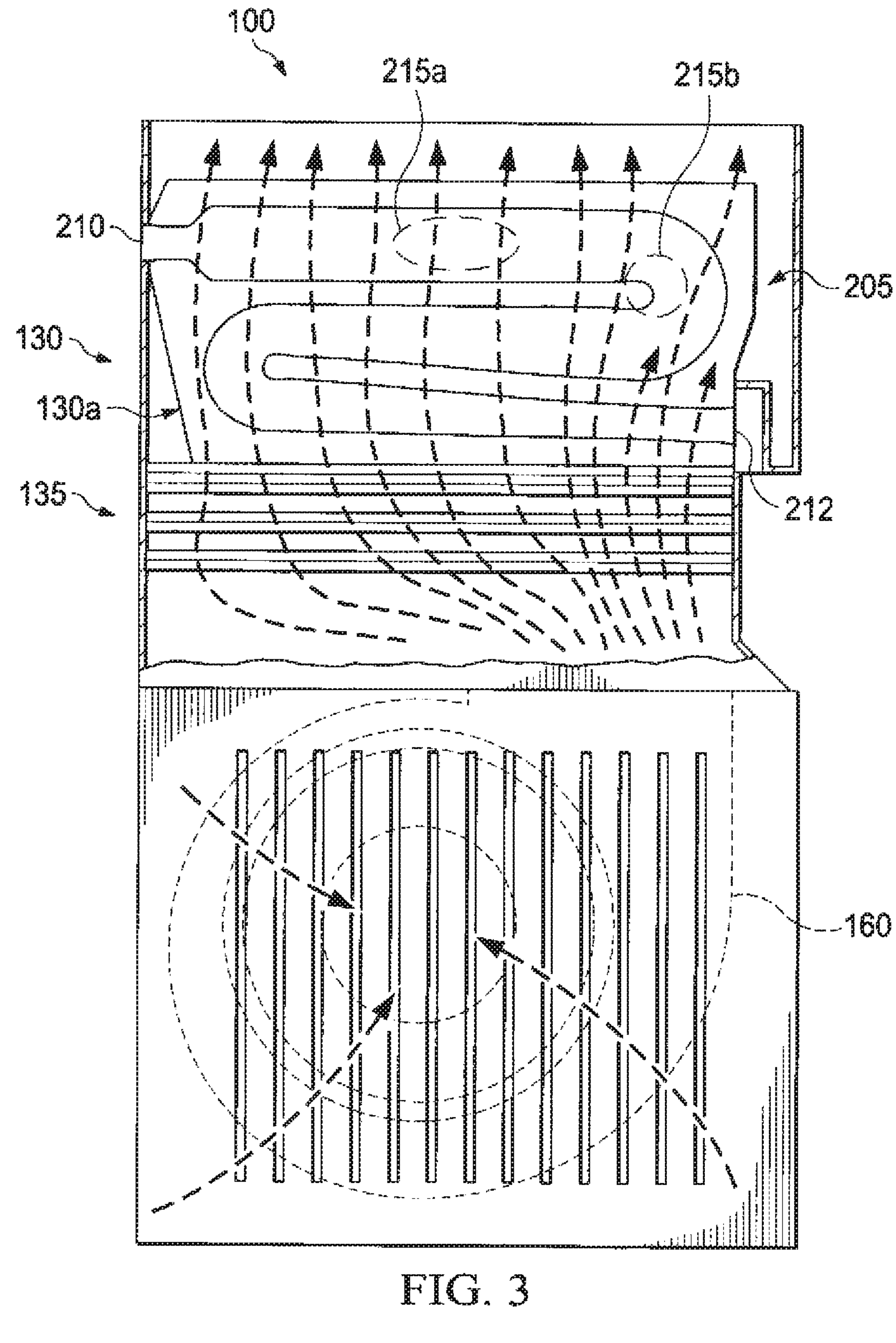
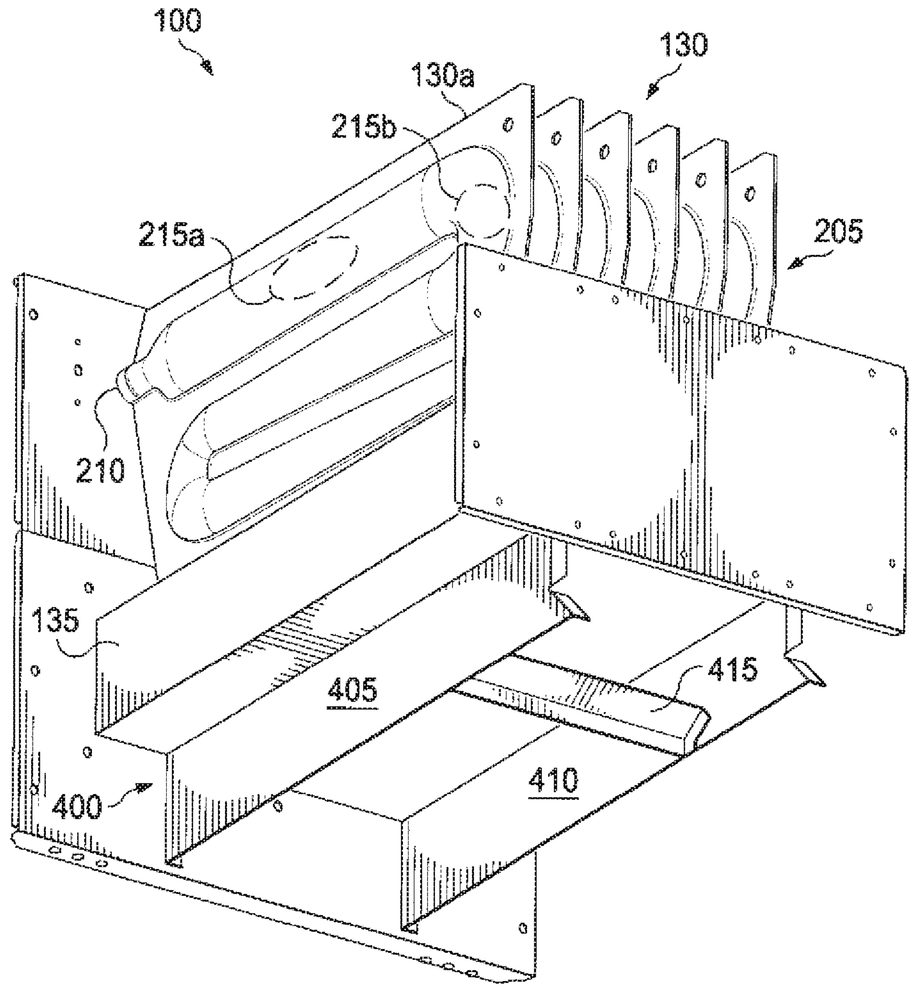
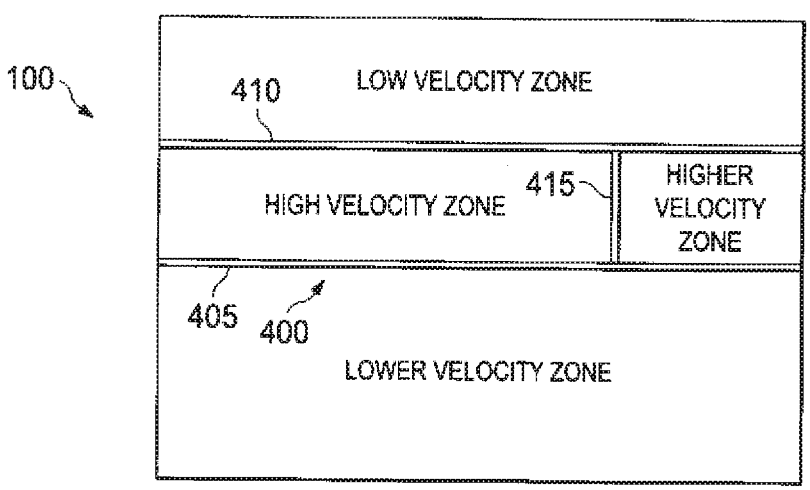


FIG. 3



100
130
130a
215b
215a
205
210
135
405
415
410
400

FIG. 4



100
410
LOW VELOCITY ZONE
HIGH VELOCITY ZONE
415
HIGHER VELOCITY ZONE
405
400
LOWER VELOCITY ZONE

FIG. 5

VELOCITY ZONING HEAT EXCHANGER AIR BAFFLE

TECHNICAL FIELD

This application is directed, in general, to heating, ventilation and air conditioning (HVAC) systems and, more specifically, to a high-efficiency furnace having a velocity zoning heat exchanger air baffle.

BACKGROUND

A conventional high-efficiency furnace typically employs several heat exchangers to warm an air stream passing through the furnace. A high-efficiency furnace is one where approximately 90% of the energy put into the furnace is converted into heat for the purposes of heating the targeted space. These high-efficiency furnaces include "clamshell" or individual panel halves formed by stamping mirror images of the combustion chambers into corresponding metal sheets and coupling them together. Often high-efficiency furnaces comprise a primary heating chamber that includes the clamshell heat exchangers or heating chambers and they often include a secondary heat exchanger/condenser. The air passes through the secondary heat exchanger/condenser from a blower or fan and then passes through the primary heat exchanger. High-efficiency furnaces are also characterized by high operating temperatures, which consistently exceed 1000 degrees. As a result, hot spots can occur at certain points in the passageway of the clam shell heat exchanger. The high operating temperatures that create these hot spots can create cracking problems in the clamshell heat exchanger panels. When such cracks appear, their occurrence is considered a failure of the system.

SUMMARY

One aspect of this disclosure provides a zoning baffle for a high-efficiency gas furnace. This embodiment comprises a housing, a primary heating zone located in the housing and comprising one or more heating chambers. A blower having an exhaust opening is located adjacent the primary heating zone and is positioned to force air through the primary heating zone. A zoning baffle is located between the blower and the primary heating zone. The zoning baffle comprises spaced apart baffles oriented substantially parallel with the one or more heating chambers.

A method of fabricating a high-efficiency furnace is also provided. One method embodiment comprises providing a housing, placing one or more heating chambers in the housing to form a primary heating zone, placing a blower having an exhaust opening within the housing and adjacent the primary heating zone and positioned to force air through the primary heating zone, and placing a zoning baffle between the blower and the primary heating zone. The zoning baffle comprises spaced apart baffles oriented substantially parallel with one or more of the heating chambers.

BRIEF DESCRIPTION

Reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

FIG. **1** illustrates an exploded isometric view of a portion of one embodiment of a furnace within which the zoning baffle may be employed;

FIG. **2** illustrates a high-efficiency heating chamber used in the furnace of FIG. **1**;

FIG. **3** illustrates a CFD analysis showing the airflow path lines through a primary heating chamber of the furnace of FIG. **1**;

FIG. **4** illustrates one embodiment of the zoning baffle as used with heating chambers within a primary heating zone of a high-efficiency gas furnace; and

FIG. **5** illustrates an embodiment of the velocity zones created by the presence of the embodiments of the zoning baffle, as provided herein.

DETAILED DESCRIPTION

Described herein are various embodiments of a zoning baffle that may be employed in a gas furnace. In one embodiment, the zoning baffle is designed to be placed within a primary heating zone of a furnace that comprises one or more heating chambers and between the primary heating zone and the blower, where it increases the air velocity and guides the air to one or more known hot spots located on one or more of the heating chambers. The purpose of the zoning baffle, as provided herein, is to reduce the temperature at the hot spots associated with each heating chamber without detrimentally increasing cubic feet per minute (CFM) airflow of the furnace, or without increasing the wattage requirements of the blower motor.

The heating chambers of current high-efficiency gas furnaces have higher surface temperatures at maximum leaving air conditions, which is typically more than 1000° F. At this temperature, a low strength steel (extra deep drawing steel known as EDDS), which is the material of choice for many manufactures, will not survive the required reliability tests. To circumvent these problems, some manufactures turn to more expensive materials or tolerate a shorter operational life of the furnace.

To use EDDS material in current high-efficiency furnace designs, it is necessary to reduce the surface temperatures of the heating chambers. Embodiments of the zoning baffle, as presented herein, have been found to lower the temperatures of the heating chambers to about 926° F., which is enough of a drop to significantly increase the life of the heating chambers, even when using EDDS materials. Certain embodiments of the zoning baffle also split or create various velocity zones and reduce the turbulence within the furnace and delivers more air to the hot spots.

Additionally, the zoning baffle can be positioned such that the higher velocity air can be directed through the maximum number of condensing coils or tubes and the lower velocity air can be directed through the minimum number of condensing coils or tubes. Within these zones, air can be redirected to known hot spots on the heating chambers without affecting airflow in the other zones. Thus, embodiments of the zoning baffles, as presented herein, increase heat transfer in the secondary or heat exchanger/condenser, which increases the annual fuel utilization efficiency (AFUE) rating of the unit. The embodiments of the zoning baffle, as presented herein, may increase AFUE up to 0.60 percent, which improves secondary tube reduction in the heat exchanger/condenser. Further, the zoning baffle sits substantially parallel to the flow velocity coming from the main blower, so it does not increase any blower watt consumption.

Additionally, it has been recognized that the gap between the fin stock of the secondary or heat exchanger/condenser and the zoning baffle improves the furnaces AFUE performance. For example, an improvement was shown for gaps ranging from about 0.125 to about 1.00 inches, with better results being obtained for a gap of about 0.50 inches. Further, the components of the zoning baffle can also be oriented in an angular position with respect to the heating chambers. Improvements were observed in angular positions that range from 0 degrees to about 25 degrees.

In general, the various embodiments of the zoning baffle provides airflow to one or more known hot spots by providing one or more high air velocity zones and a surface along which airflow travels, thereby effectively guiding the airflow to the desired area on the heating chamber and at higher velocities. Without being limited by any theory of operation, it is believed that the airflow guidance is based on the coanda effect, wherein the fluid airflow is attracted to the flat surfaces of the zoning baffle. The guidance of the airflow causes the air to be directed more toward hot spots of the heating chambers, thereby reducing the temperature of the heating chambers and keeping their operating temperature within design parameters, which prevents premature stress and cracking in the area of the hot spot, even with EDDS type materials are used. This advantage allows manufacturers to use the cheaper construction materials without sacrificing operation life, while at the same time reducing manufacturing costs.

Though the zoning baffle, as presented herein, could be used in any furnace chamber, it provides particular benefits when employed in high-efficiency furnaces where 90% of the total amount of fuel used is converted directly into heat. The benefits arise from the fact that these high-efficiency furnaces reach higher operational temperatures, which causes the heating chambers to prematurely stress and crack at the above-mentioned hot spots. As stated above, the zoning baffle guides more airflow at high air velocities to these hot spots, which reduces stress and premature cracking in the heating chambers.

FIG. **1** is an exploded isometric view of a portion of one embodiment of a high-efficiency furnace **100** within which embodiments of the zoning baffle, as presented herein, may be employed. The furnace includes a housing **102** having a front opening **105** within which a mounting shelf **110** is located. The mounting shelf **110** has an opening **115** therein and supports a heat exchanger assembly **120** over the opening **115**. The illustrated embodiment of the heat exchanger assembly **120** has a primary heating zone **130** that includes a row of six heating chambers (one referenced as **130***a*) coupled to an inlet panel **122**. Alternative embodiments of the heat exchanger assembly **120** have more or fewer heating chambers **130***a* coupled to the inlet panel **122** in one or more rows. In the illustrated embodiment, the heating chambers **130***a* form the primary heating zone **130** and are generally serpentine and have two approximately 180° folds such that the heating chambers **130***a* cross over the opening **115** at least three times, terminating in inlets **132** and outlets **134** that are generally mutually coplanar and oriented toward the opening **105** of the housing **100**. In certain embodiments, the heat exchanger assembly **120** may further include a conventional secondary heat exchanger zone **135** that is a heat exchanger/condenser.

A burner assembly **140** contains a thermostatically-controlled solenoid valve **142**, a manifold **144** leading from the valve **142** and across the burner assembly **150**, one or more gas orifices (not shown) coupled to the manifold **144** and one or more burners (not shown) corresponding to and located proximate the gas orifices. The illustrated embodiment of the burner assembly **140** has a row of six burners. Alternative embodiments of the burner assembly **140** have more or fewer burners arranged in one or more rows. A flue **146** allows undesired gases (e.g., unburned fuel) to be vented from the burner assembly **140**. In an assembled configuration, the burner assembly **140** is located proximate the heat exchanger assembly **120** such that the burners thereof at least approximately align with the inlets **132**.

A draft inducer assembly **150** contains a manifold **152**, a draft inducing exhaust fan **154** having an inlet coupled to the manifold **152** and a flue **156** coupled to an outlet of the exhaust fan **154**. In an assembled configuration, the draft inducer assembly **150** is located proximate the heat exchanger assembly **120**, such that the manifold **152** thereof at least approximately aligns with the outlets **134** and the flue **156** at least approximately aligns with the flue **146** of the burner assembly **140**.

A blower **160** is suspended from the shelf **110** such that an outlet **162** thereof approximately aligns with the opening **115**. An electronic controller **170** is located proximate the blower **160** and, in the illustrated embodiment, controls the blower, the valve **142** and the exhaust fan **154** to cause the furnace to provide heat. A cover **180** may be placed over the front opening **105** of the housing **100**.

In the illustrated embodiment, the controller **170** turns on the exhaust fan to initiate a draft in the heat exchangers (including the primary heating zone **130**) and purge potentially harmful unburned gases or gaseous combustion products. Then the controller **170** opens the valve **142** to admit gas to the manifold **144** and the one or more gas orifices, whereupon the gas begins to mix with air to form primary combustion air. Then the controller **170** activates an igniter (not shown in FIG. **1**) to attempt to ignite the primary combustion air. If the output of a thermocouple indicates that the primary combustion air has not ignited within a predetermined period of time, the controller **170** then closes the valve **142** and waits until attempting to start again. If the output of a thermocouple indicates that the primary combustion air has ignited within the predetermined period of time, the controller **170** then activates the blower, which forces air upward through the opening **115** and the heat exchanger assembly **120**. As it passes over the surfaces of the heat exchangers, the air is warmed, whereupon it may be delivered or distributed as needed to provide heating.

FIG. **2** illustrates an embodiment of one of the high-efficiency heating chambers **130***a*, as referenced above. The heating chamber **130***a* may be a clamshell design wherein mirrored halves are joined together in a conventional manner to form a heating chamber panel. Typically, the two mirrored halves are joined by one half overlapping the edge of the other and being crimped together or joined in another conventional manner. The heating chamber **130***a* has a backend **205** adjacent an outlet end **212** (exhaust end). Ignited gas enters the heating chamber **130***a* at an inlet end **210** and traverses the chamber pathway and exits the heating chamber **130***a* at outlet end **212**. Due to the high-efficiency characteristics of the heating chamber **130***a*, hot spots **215***a*, **215***b* can develop during the operation of the furnace, and which overtime, can fatigue the metal and cause it to crack. The location of the hot spots **215***a*, **215***b* can be determined by obtaining readings from a thermocouple placed on the heating chamber **130***a*. As noted above, in conventional designs, to extend the life of the heating chamber **130***a*, manufacturers have fabricated the heating chambers from a more expensive sheet material to prevent premature cracking and failure of the heating chamber **130***a*. However, when used with the embodiments of the zoning baffle, as described herein, the above-mentioned EDDS material can be used, thereby reducing manufacturing costs, while maintaining a high quality operational life of the heat chamber **130***a*.

FIG. **3** is a CFD analysis showing the velocity of the airflow through the primary heating zone **130**. The air leaves the blower at a high velocity of about 1500 feet per minute.

However, by the time the air passes through the secondary heating/condensing zone **135** and enters the primary heating zone **130**, the velocity of the air significantly decreases to about 500 feet per minute, and in some areas of the primary heating zone **130**, the air velocity can decrease to about 300 feet per minute. As a result, the temperature of the heating chambers **130***a* can increase to temperatures as much as 1000° F. However, as explained below, the presence of embodiments of the zoning baffle creates higher velocity zones in the primary heating zone chamber **130** and also guides more air to the hot spots **215***a*, **215***b*, thereby providing additional heat dissipation, which in turn, reduces the stress and premature cracking associated with its operation and extends the life of the heating chamber **130***a*.

FIG. **4** illustrates one embodiment of the zoning baffle **400**. This embodiment is comprised of spaced apart baffles **405**, **410** oriented substantially parallel with one or more of the heating chambers **130***a*, as shown. The heating chambers **130***a* are spaced apart such that an air flow generated by the blower **160** will pass between the heating chambers **130***a*. The distance that the baffles **405**, **410** are spaced apart will depend on the determination of the hot spots on the heating chambers **130***a*. For example, if the hot spots are located more within the inner portion of the primary heating zone **130**, the baffles **405**, **410** will be positioned so that a higher velocity zone is created about those particular heating chambers **130***a*. If a greater number of heating chambers **130***a* also have hot spots, the spacing between the baffles **405**, **410** will be greater to include those additional heating chambers **130***a*.

In one embodiment, the zoning baffle **400** is positioned between the blower **160** and the primary heating zone **130**. (See FIG. **1**). However, in an alternative embodiment, the zoning baffle **400** is positioned between the blower **160** and the conventional secondary heat exchanger/condenser zone **135** (See FIG. **1**). In one aspect of this embodiment, the baffles **405**, **410** may deviate from a true parallel or vertical position with respect to the heating chambers **130***a*. For example, the angle of orientation of the baffles **405**, **410** may range from 0 degrees to about 25 degrees and still be considered to be substantially parallel with the heating chambers **130***a*, as that phrase is used herein and in the claims. In one embodiment, the baffles **405**, **410** are substantially smooth, planar panels, allowing for manufacturing variances that provide a surface along which the air from blower **160** may flow. This results in a zoning effect that more efficiently directs the air to hot spots within the primary heating zone **130**. Improvement was shown in the temperature reduction of the heating chambers **130***a* when the baffles **405**, **410** were oriented within the above-noted range. However, a 0 degree orientation was found to give better results in temperature reduction of the heating chambers **130***a* than other orientations.

In another aspect, the zoning baffle **400** further includes a cross baffle **415** that extends between the baffles **405**, **410**. In one embodiment, the cross baffle **415** comprises an elongated plate that is bent to form opposing plates having an angle of separation between and extends perpendicularly between the baffles **405**, **410**. The cross baffle **415** may be rotated from a horizontal position by 0 degrees to about 45 degrees, with about degrees giving better results than other orientations. Additionally, as with the baffles **405**, **410**, the location of the cross baffle **415** within the primary heating zone **130** will depend on the location of the hot spots that are positioned more toward the back end **205** of the heating chambers **130***a*. In one embodiment, the cross baffle **415** creates a higher velocity zone than is created by the baffles **405**, **410**. The high velocity provides greater air flow through that portion of the primary heating zone **130**, thereby reducing the occurrence of hot spots that cause premature cracking.

FIG. **5** illustrates an overhead view of the primary heating chamber **130** in which the zoning baffle **400** is implemented. As seen in this view, the zoning baffle **400**, which in this embodiment includes the cross baffle **415**, creates the various velocity zones as indicated in FIG. **5**. The high and higher velocity zones are zones where air flow velocity is increased due to the presence of the zoning baffle **400**. This along with the baffles **405**, **410** and cross baffle **415** directs more air to known hot spot areas, which provides the above-discussed advantages.

With reference to FIGS. **1**-**5**, in one embodiment of a methodology of fabrication of a high-efficiency gas furnace, there is provided a method of fabricating a high-efficiency gas furnace **100**. This embodiment comprises providing a housing **102**, placing a primary heating zone **130** within the housing **100** that includes spaced apart heating chambers **130***a*, wherein each of the heating chambers **130***a* has one or more pre-determined hot spots **215***a*, **215***b* associated therewith, and located adjacent an outlet end **212** of each of the heating chambers **130***a*. The method further comprises placing a blower **160** having an exhaust opening **162** within the housing **100** and adjacent the primary heating zone **130** and positioned to force air through the primary heating zone **130**. A zoning baffle **400** is positioned between the blower and the primary heating zone **130**. The zoning baffle comprises spaced apart baffles **405**, **410** oriented substantially parallel with one or more of the heating chambers **130***a*, and in one application, the baffles **405**, **410** are separated by a distance that is less than a width of the exhaust opening **162**.

In one embodiment, an angle of orientation of the baffles **405**, **410** from the substantially parallel or vertical orientation with respect to the heating chambers **130***a* ranges from 0 degrees to about 25 degrees. In another embodiment, the step of placing a zoning baffle further comprises placing a cross baffle **415** between the baffles **405**, **410** and that extends between the baffles **405**, **410**. In one aspect of this embodiment, the cross baffle **415** comprises an elongated plate that is bent to form opposing plates having an angle of separation between. In another aspect, zoning baffles **405**, **410**, **415** create a first air velocity zone and a second higher air velocity zone.

In another embodiment, the method further comprises placing a secondary heat exchanger/condenser zone **135** within the housing **102**, located adjacent the primary heating zone **130**, wherein the secondary heating zone is located between the zoning baffle **400** and the primary heating zone **130**.

Those skilled in the art to which this application relates will appreciate that other and further additions, deletions, substitutions and modifications may be made to the described embodiments.

What is claimed is:

1. A gas furnace, comprising:

a housing;

a primary heating zone located in said housing and comprising one or more heating chambers;

a blower having an exhaust opening and located adjacent said primary heating zone and positioned to force air through said primary heating zone;

a zoning baffle located between said blower and said primary heating zone, said zoning baffle comprising spaced apart baffles oriented substantially parallel with said one or more heating chambers; and

wherein the one or more heating chambers comprises a plurality of heating chambers and wherein the spaced apart baffles of the zoning baffle are inboard of at least one of the plurality of heating chambers.

2. The gas furnace of claim **1**, wherein said zoning baffle further includes a cross baffle that extends between said spaced apart baffles.

3. The gas furnace of claim **2**, wherein said cross baffle comprises an elongated plate that is bent to form opposing plates having an angle of separation between.

4. The gas furnace of claim **2**, wherein said zoning baffle comprises a first air velocity zone and a second higher air velocity zone.

5. The gas furnace of claim **2**, wherein said cross baffle is oriented at an angle with respect to a horizontal position ranging from 0 degrees to about 45 degrees.

6. The gas furnace of claim **5**, wherein said angle is 45 degrees.

7. The gas furnace of claim **1**, wherein an angle of orientation of said spaced apart baffles from said substantially parallel orientation at an angle that ranges from 0 degrees to about 25 degrees.

8. The gas furnace of claim **7**, wherein said angle is 0 degrees.

9. The gas furnace of claim **1**, wherein said spaced apart baffles are separated by a distance that is less than a width of said exhaust opening.

10. The gas furnace of claim **1** further comprising a secondary heat exchanger/condenser zone located within said housing and adjacent said primary heating zone, wherein said secondary heating zone is located between said zoning baffle and said primary heating zone.

11. A method of fabricating a gas furnace, comprising:

providing a housing;

placing one or more heating chambers in said housing to form a primary heating zone;

placing a blower having an exhaust opening within said housing and adjacent said primary heating zone and positioned to force air through said primary heating zone;

placing a zoning baffle between said blower and said primary heating zone, said zoning baffle comprising spaced apart baffles oriented substantially parallel with one or more of said heating chambers; and

wherein the step of placing one or more heating chambers comprises placing a plurality of heating chambers and wherein the spaced apart baffles of the zoning baffle are inboard of at least one of the plurality of heating chambers.

12. The method of claim **11**, wherein placing a zoning baffle further includes placing a cross baffle between said spaced apart baffles that extends between said spaced apart baffles.

13. The method of claim **12**, wherein said cross baffle comprises an elongated plate that is bent to form opposing plates having an angle of separation between.

14. The method of claim **12**, wherein said placing a zoning baffle comprises creating a first air velocity zone and a second higher air velocity zone.

15. The method of claim **11**, wherein said spaced apart baffles are separated by a distance that is less than a width of said exhaust opening.

16. The method of claim **11** further comprising placing a secondary heat exchanger/condenser zone within said housing and adjacent said primary heating zone, wherein said secondary heating zone is located between said zoning baffle and said primary heating zone.

17. The method of claim **11**, wherein an angle of orientation of said spaced apart baffles from said substantially parallel orientation ranges from 0 degrees to about 25 degrees.

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